Defense Technical Information Center Compilation Part Notice

ADP010980

TITLE: A Consideration of Obsolescence within the Design of Modern Avionics Test Systems

DISTRIBUTION: Approved for public release, distribution unlimited

This paper is part of the following report:

TITLE: Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components [Strategies visant a attenuer l'obsolescence des systemes par l'emploi de composants du commerce]

To order the complete compilation report, use: ADA394911

The component part is provided here to allow users access to individually authored sections of proceedings, annals, symposia, etc. However, the component should be considered within the context of the overall compilation report and not as a stand-alone technical report.

The following component part numbers comprise the compilation report:
ADP010960 thru ADP010986

A Consideration of Obsolescence within the Design of Modern Avionics Test Systems

(25. October 2000)

Rainer Bach
EADS Deutschland GmbH
Defence Electronics and Telecommunication
Airborne Systems
Wörthstr. 85, 89077 Ulm
Germany

Thomas Mayer
EADS Deutschland GmbH
Defence Electronics and Telecommunication
Airborne Systems
Wörthstr. 85, 89077 Ulm
Germany

Paul Charbonnier
EADS France
Systems Services and Telecommunication
Test & Services
316, route de Bayonne, 31060 Toulouse Cedex 03
France

1. Summary

Considering obsolescence in avionics systems firstly leads to the obsolescence of the so called prime equipment. This means the equipment of which an avionics system is built. Normally the support equipment is more or less ignored or the analysis is postponed to a later date.

This situation was the challenge for us to work on a "Consideration of Obsolescence within the Design of Modern Avionics Test Systems".

We analysed today's situation and differentiated our analysis in the (COTS) market, customer requirements and technology.

During our analysis we decided to not only analyse the obsolescence situation within the test systems design, because obsolescence within the design of modern avionics test systems is only one of the determining factors. All factors have to be merged into a design concept inside of which single factors can't be considered stand alone.

Our solution – covering the requirements of the end user of our systems – consists of a design concept covering the test systems critical interfaces, test system standards and the philosophy of standardised units.

This approach ensures the flexibility in hardware and software to adapt quickly as needed on the commercial market and to guarantee the long term support as needed on the military market.

The approach is adaptable to various maintenance and service concepts providing each customer (nation) with its own In-Service concept supporting mobile and fixed service stations.

We are convinced that our concept ultimately benefits to our customer without ignoring the interests of industry.

2. List of Abbreviations and Acronyms

Abbreviation	Explanation
A/C	Aircraft
AGE	Aerospace Ground Equipment
ATE	Automatic Test Equipment
COTS	Commercial Off The Shelf
EADS	European Aeronautic, Defence and Space Company
GPATE	General Purpose Automatic Test Equipment
HW	Hardware
IETD	Interactive Electronic Technical Documentation
LRU	Line Replaceable Unit
RF	Radio Frequency
STTE	Special to-Type Test Equipment
SW	Software
TPS	Test Programme Set

3. Introduction

3.1. History/Experience

We, of the Airborne Systems Division of EADS Deutschland and Test and Services Division of EADS France, have a long lasting experience in the design, development and production of modern

Paper presented at the RTO SCI Symposium on "Strategies to Mitigate Obsolescence in Defense Systems Using Commercial Components", held in Budapest, Hungary, 23-25 October 2000, and published in RTO MP-072.

avionics test systems. During the last ten years an additional test systems line - the Mobile Test Systems - has been established by both A.M. Divisions of EADS. Together we cover a wide range of test systems and applications.

The range of applications of Airborne Systems test systems extends from development test systems over production test systems right up to customer test systems. Various test applications for radar, electronic warfare, optical and general avionics equipment have been developed.

The range of applications of the test systems of Test and Services extends from development test systems over production test systems right up to customer test systems as well for the civil as for the military markets. More than 3500 test applications for avionics equipment have been developed.

Both divisions of EADS have the experience with more than one thousand of produced test systems, installed world wide both for Aeronautic and Defence applications.

3.2. The Problem

Our aim of looking at the problems of obsolescence within the design of modern avionics test systems involves a detailed analysis and the definition of a handy solution that can be easily applied to various test systems.

The title and contents of this article differ slightly from the others which dealt mainly with the so called prime equipment of the defence systems.

When dealing mainly with obsolescence problems within the design of prime equipment, there is a big risk that the associated logistic support will be neglected or left out.

Avionics test systems belong to the support equipment – Aerospace Ground Equipment (AGE) - that keeps the prime equipment in operation. Usually the main attention of military procurement organisations is drawn to the prime equipment. To our understanding it is very important, that the support equipment also has to be considered. This equipment has to support the military systems during their whole life cycle. This means, that the life time period is normally much longer than the development and production period of the prime equipment.

The awareness of the problems of obsolescence within the design of test systems comes up earlier than for prime equipment. Test systems normally are not flight critical, therefore they have not to fulfil the very hard qualification requirements of equipment that is use in an aircraft. For test systems COTS equipment can be used.

The traditionally long procurement periods of military equipment sometimes result in obsolescence problems even before the In-Service-Date of the equipment. The Military Customers, as well as industry, have to cope with new challenges.

During the last decades, test systems were often designed as Special to-Type Test Equipment (STTE) for a dedicated application, for a particular prime equipment.

In addition to the STTE solution, several approaches were made to develop universal test systems that were capable of supporting multiple applications. Unfortunately this traditional “Common Core Test Concept” sometimes leads to “overpowered” core systems and made upgrade programmes during the development and In-service phase difficult and expensive.

The exceedingly short innovation periods of commercial computers and measurement devices have forced EADS to optimise the concept for the development of Test Systems.

We analysed the situation of obsolescence in the design of modern avionics test systems. One important conclusion was, that we not only have to consider the obsolescence of the hardware components of our test systems, but that we also have to consider the software.

We concentrated our analysis on developing a conceptual approach, that fits in with the complete life cycle of our test systems.

4. Today’s Situation in The Design of Modern Avionics Test Systems

4.1. General

Firstly, we analysed today’s situation in the design of modern avionics test systems. We divided this analysis up into three different categories:

- COTS market
- customer requirements
- technology

All the above three elements touch the different obsolescence problems we have to cope with.

In a very early stage of our analysis, it was clear to us that obsolescence problems must be considered not as stand-alone problems, but in connection with all the other elements involved. A stand-alone consideration can be made regarding individual components; e.g. if a PC board has to be developed and one or more components become obsolete. This stand-alone consideration, however, is not meaningful during the development of test systems that are made up of different equipment.

Therefore we developed a test system solution which covers nearly all aspects of the problems within the design of modern avionics test systems - including obsolescence as one major element.

How do we avoid, or better - mitigate -, the problems resulting out of obsolete items?

Before answering this question, let us look a little bit closer at the three different categories.

4.2. Today's Situation - COTS Market -

The COTS (Commercial Off the Shelf) market, especially for computers and measurement/stimuli devices, is expanding and changing faster than ever before.

Obsolescence and non availability of computer HW and SW, as well as obsolescence of measurement and stimuli devices, become a day to day problem.

Standards are no longer being defined by military requirements (only). Nowadays they are mainly influenced by the commercial acceptance of systems.

Commercial software is frequently upgraded, sometimes without notifying the customers; a downward compatibility is not always guaranteed. .

4.3. Today's Situation - Customer Requirements -

Ongoing changes in a nation's maintenance philosophy result in extreme flexibility within the necessary test system development. These changes are mainly driven by reduced budgets, changing operational requirements and adaptation to international / multinational programmes.

Increasing the complexity of the avionics systems, combined with the decreasing availability and capability of military operators, lead to a requirement for "Intelligent Test System Solutions".

The service periods of military operators is continuously being reduced, as is the quantity of qualified staff. The qualification of the operators is sometimes not sufficient for the tasks to be carried out. Therefore the test systems have to compensate this lack of qualification. In addition to the traditional tasks of a test system, the power of the integrated computer systems allow an increased spectrum of usability. There is an upcoming requirement for diagnostic capability, integrated training features and IETD (Interactive Electronic Technical Documentation).

Prime equipment upgrade programmes require - during the test systems life cycle - an implementation of several types/generations of technologies into the test systems. For example: during a mid-term upgrade programme, new electronic equipment is integrated into an old aircraft. This means, you have to manage different configurations of avionics equipment in parallel, that will have to be maintained by the test systems for a long time.

4.4. Today's Situation - Technology –

Decreasing budgets and reduced order quantities force developers of military test systems to design solutions based on commercial products in almost every new project development phase. The consequence is, that problems are appearing with obsolete items.

Traditional test concepts, such as large universal test systems, may lead to "overpowered" core systems, test systems being designed to cover all possible test requirements for the respective equipment or system. Ballast caused by commonality make upgrade programmes - during the product life cycle - difficult and expensive. The necessary flexibility is not available. Extreme short innovation cycles of avionics systems require a high flexibility and growth potential in the design of test systems.

In the past, avionics prime equipment had innovation cycles of ten and more years. Today these innovation cycles are much shorter, sometimes only a few years.

4.5. Requirements of the End User

Derived out of today's situation we have tried to sum up the requirements and concerns of the end user of modern avionics test systems. This list might not be complete, but we think that it covers at least all the main topics.

We always have to keep in mind, that the obsolescence problems can not be considered stand-alone, but within a complete picture.

A new test system should:

- take into account existing test systems already in use
- use an existing development & production SW where possible
- start with a low cost "Basic Core System"
- use a modular design, easy to maintain and to upgrade
- prevent redundant test-resources
- be configurable to specific purpose / national applications / country specific features (extendable on time schedule with additional resources and applications)
- allow TPS (Test Programme Set) programming to be independent of test-resources
- provide user friendly man machine interfaces
- facilitate TPS programming by prime equipment supplier
- allow easy interfacing of specific test devices needed only for one TPS

All these requirements and concerns should be addressed against the background of long term life cycle management over a period of 20-40 years.

You should know the customers requirements before you start to design and develop a test system. The military customer is looking for a long term serviceability of our solutions, but also wanting state-of-the-art solutions.

There is a British saying that describes that situation very well. We have "to kill two birds with one stone". In fact, in reality: not two...but many birds ...

5. Solutions

5.1. General

Obsolescence is a problem which is with us to stay. Developers must find a way to minimise its effect. But it has to be clear, that the obsolescence problem has to be considered in connection with all the other determining factors.

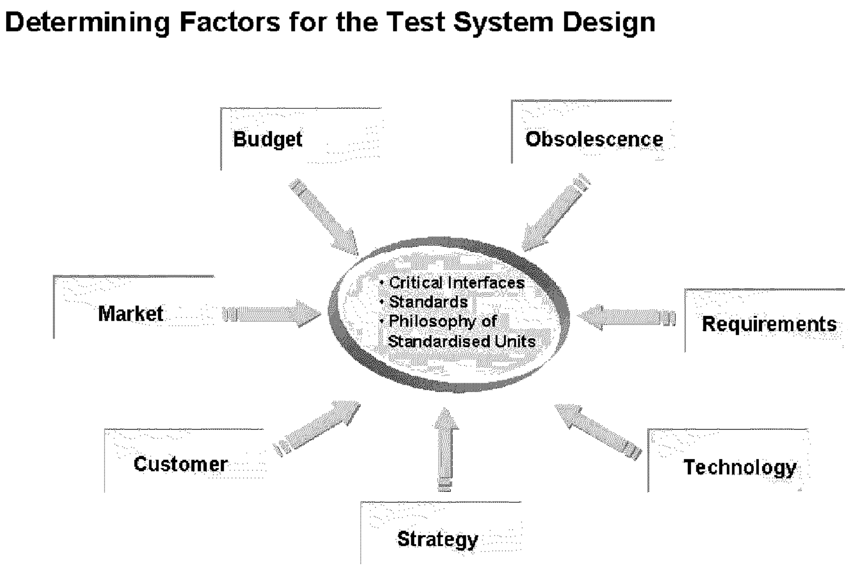

Illustration 1: Determining Factors for the Test System Design

One way of solving a large majority of the obsolescence problems is to

- analyse the critical interfaces
- consider the available standards
- use standard units

i.e. use units which can, without alteration, be built into numerous test systems.

During this process you have to be reasonable and as far as possible you have to foresee upcoming problems.

This methods not only reduces development costs, but also ensures that any up-coming obsolete items are dealt with, over a wide range of equipment, thus reducing the cost of the problem.

5.2. Test Systems Critical Interfaces

Defining and using Critical Interfaces between the subsystems and components of an ATE is a key factor for "The Philosophy of Standardised Units".

The choice of these interfaces defines the level of modularity and flexibility of the test system in terms of:

- Capability to host TPS and to grow in configuration depending on the units to be tested with the:
  - Capability to install easily TPS on the ATE,
  - Capability to configure the ATE to support a given set of LRU's
  - Capability to expand to support more LRU's
  - Capability to expand or change to support modified LRU's
- Capability to adapt to user's needs with the:
  - Capability to modify or replace the Man Machine Interface
  - Capability to add, modify or replace tools such as documentation viewer, test results, data bases, ……
- Capability to deal with obsolescence of components with the:
  - Capability to replace the test control computer,
  - Capability to replace the operating system,
  - Capability to add new ATE system buses,
  - Capability to expand the switching system,
  - Capability to add or replace test resources,
  - Capability to add or replace software components including compiler and run time system used for TPS.

The illustration 2 below shows the main typical interfaces needed to support the above requirements.

These test system critical interfaces are a challenge for customers and suppliers. They not only need to be carefully defined but also to be implemented by standard, insuring freedom of choice for components and long term support. This topic will be discussed in the next paragraph (5.3).

There are other key factors for success to consider such as (and not limited to):

- Avoid the change of critical interfaces,
- Keep requirements on a very high level
- Built systems based on commercial equipment (COTS)
- Buy from supplier that has many customers to have the chance of amortising/splitting the cost of obsolescence. If you are by yourself you have to pay 100%.
- Convince suppliers of key COTS item to buffer changes of components to avoid to pay charges for obsolescence, order batches not single items
- You need to be fast in the development of your systems, they shouldn't be obsolete when put on the market.

.

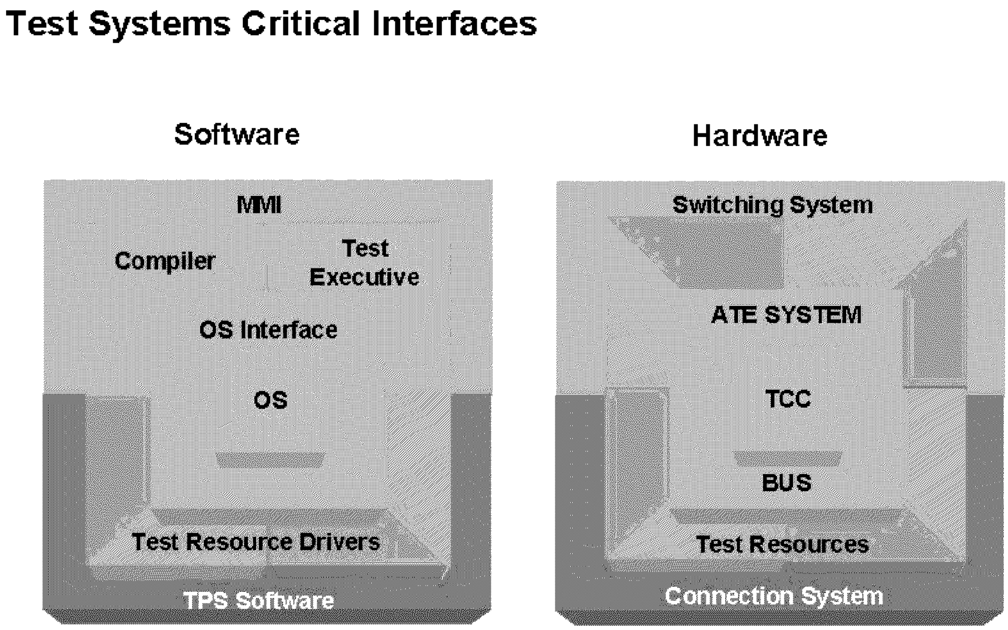

Illustration 2: Test Systems Critical Interfaces

5.3. Test System Standards

The critical interfaces discussed above should be implemented by standard ensuring:

- freedom of choice for components,
- long term support.

The technologies available today in the area of computers and instrumentation allow to find off-the-shelf industrial standards to match most of the ATE system critical interfaces.

However, these standards may change too fast to ensure at the same time the freedom of choice for components and a long term support matching the life cycle of the defence systems.

In order to address this problem we recommend to differentiate between:

- Very Critical Interface that ensures the portability and rehosting of TPS and protects most of the investment in test applications,
- Critical Interfaces internal to the ATE itself,

The Very Critical Interfaces are made up of the TPS programming language and of the ATE connection system. The standard in these area shall be stable for at least 20 years in order to protect the investment made in developing test applications. Industrial standard may not be up to the task without the effort of aeronautic and defence customers to define, use and enforce such standard.

On the other hand, the Critical Interfaces shall be off-the-shelf standard widely used by the industry. Their rate of change should be of at least 5 years. The customers should avoid to enforce these standards in order to make possible the best choice of components. The computer and software technologies available today made it possible to adapt and interface between the different standards at a reasonable cost, whenever changes cannot be avoided.

5.4. Philosophy of Standardised Units

With our background of a wide spectrum of different applications and the experience of many national and international programmes, EADS developed the "Philosophy of Standardised Units".

The idea of The Philosophy of Standardised Units is not new. The principle uses a pool of existing standard units for the various applications comprising of:

- Controller
- Commercial Software
- Specific Software
- Digital Measurement Equipment
- RF Measurement Equipment
- Power Supplies and
- Mountings.

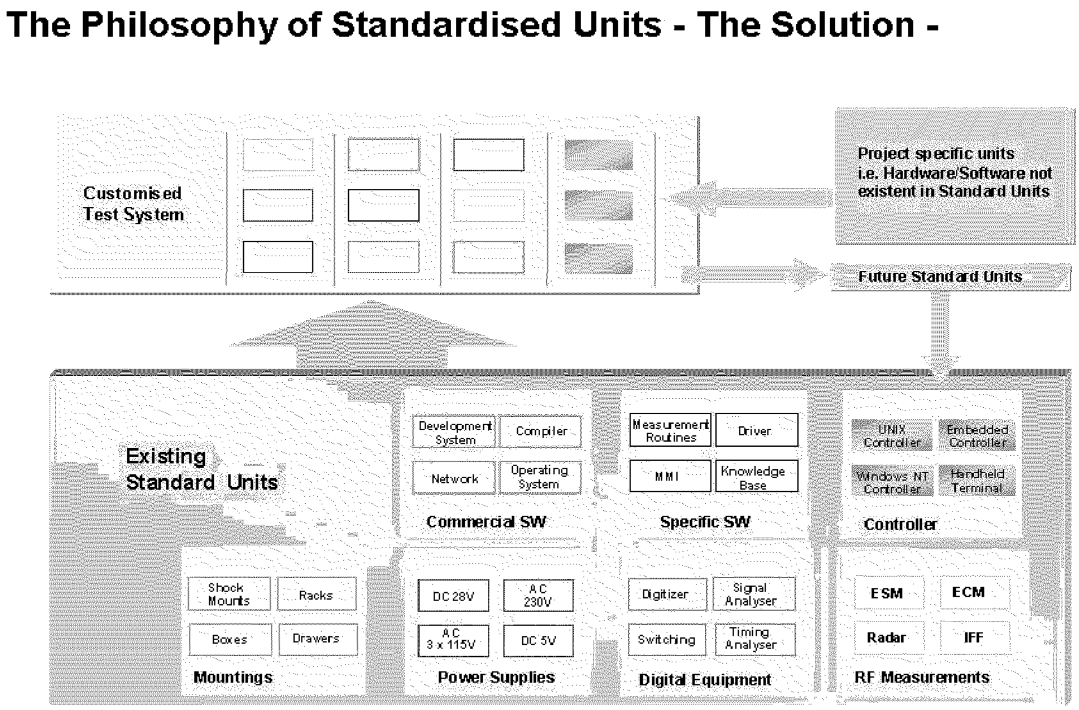

Illustration 3: The Philosophy of Standardised Units - The Solution -

The core system, and all the elements that are suitable for reaching the development goal, are built up out of this pool. They are amended by project specific units, i.e. hardware/software that is not yet existent in the pool of standard units.

In the next step, the product “New Test System” is analysed and all the new elements that are suitable for integration into the standard pool are identified and added to it. The “old” existing elements will be upgraded to keep the pool up-to-date.

The “Philosophy of Standardised Units” comprises the following technological and design requirements.

Technology

- To use state-of-the-art technology in test and measurement devices
- To maximise use of COTS Equipment
- To use technology with long term availability
- To prevent obsolescence

Design

- To define a test system design/architecture which achieves long term maintainability (i.e. allowing a change of test and measurement devices in HW and SW without changing the application)
- To maximise use of existing Test Programme Sets
- To allow growth potential
- To use international standards
- To create a common philosophy, useable for various/multiple maintenance concepts like shop, flight-line, modular, fixed, mobile, etc.

The first main advantage of the philosophy of standardised units is the flexibility in hardware and software, having the capability to react on the commercial market by being independent of types of equipment and/or manufacturers. This philosophy guarantees the long term support for the military market over the long support periods, that are required by the military customers.

To a certain extend interchangeability and even backward compatibility of the used test systems units can be accommodated..

The second main advantage is that it is adaptable to various maintenance and service concepts.

It is possible to provide each customer and each nation with its own In-Service concept without necessarily inventing a new test system. This can be achieved by using mainly the available pool. The concept also supports different applications of mobile - on aircraft, deployable - and fixed - development, production, shop - service stations.

Apart from the two cardinal advantages, it is worthwhile mentioning advantages like reduction of the cost for operator training and refresher courses by using well know elements and standard man machine interfaces.

The Philosophy of Standardised Units represents a design concept for test systems which allows flexibility for the insertion of new technology in the future and growth within the test systems.

6. Conclusion

We are sure that we are at the beginning of a development process in the design of modern avionics test systems that forces all involved companies to redefine their concepts. We are however also convinced that our concept of standardised units can't be implemented in a very short time.

Obsolescence in the design of modern avionics test systems is not only a matter of component obsolescence; measurement and stimuli equipment have to be considered as well as computer HW and SW.

A consideration of single HW or SW elements leads to a collection of single solutions. These solutions are often contradictory, and expensive.

Our solution points out a cost optimised way of integrating COTS products - including all the well known obsolescence problems - in a philosophy/strategy that is optimised for military requirements, e.g. long term availability/supportability.

The possibility of a continuous engineering process in the design and development of modern avionics test systems - taking into consideration already existing SW- and HW elements - guarantees a constant market presence at the front-end of the technological development.

The design concept is an evolutionary approach based on the existing test system design and it ensures maximum re-use of the current design to protect the investments already made.

All the above mentioned activities ultimately benefit our customers, but the active co-operation of the customer is required.

Our intention was to combine the best on whatever level necessary, and, if we may be so bold as to mention it, we think that we have achieved just that.